PART C

DISPOSAL SITE DESIGN

SECTION C.1

ENGINEERING DESIGN

C.1 ENGINEERING DESIGN

C.1.1 REGULATORY CRITERIA

The GCLF has been designed and will be permitted and operated in compliance with Class III landfill standards set forth in 27 CCR and 40 CFR. Section C.2 presents a description of the waste containment design of the refuse disposal area.

All municipal solid waste landfills are subject to Federal regulations which became effective on October 9, 1993 under the Resource Conservation and Recovery Act, also known as Subtitle D. The Subtitle D regulations were promulgated under 40 CFR, Parts 257 and 258. One of the most important aspects of Subtitle D (40 CFR 258.40) requires operators of municipal solid waste landfills to construct a composite or approved engineered alternative liner system in new waste management units, lateral expansions, or areas within a previously permitted waste management unit which had not had refuse placed within them as of October 9, 1993.

Subtitle D defines a composite liner as a system consisting of two low-permeability components. The upper component must consist of a minimum of 30-mil flexible membrane liner (FML) and the lower component must consist of at least a two-foot layer of compacted soil with a hydraulic conductivity of no greater than 1×10^{-7} cm/sec. FML components consisting of HDPE shall be at least 60-mil thick. Additionally, a leachate collection system must be installed above the composite liner system with the design capability to maintain less than a 30-cm (12 inches) depth of leachate over the liner. The GCLF composite liner system and LCRS meets and exceeds 40 CFR 258.40 requirements for the refuse disposal area.

27 CCR, Section 20240 requires that all new landfills be sited, designed, constructed and operated to ensure that wastes will be a minimum of five feet above the highest anticipated elevation of underlying groundwater. The waste containment unit can either be situated above the highest anticipated groundwater level or the operator may propose an engineered alternative. The GCLF project was designed to create the required five feet of separation

between underlying groundwater and the landfill. The bottom subgrade will be a minimum of five feet above the highest anticipated groundwater level.

In addition to engineering the GCLF to accommodate a five-foot separation (i.e., placing the bottom grades above the peizometric surface), the design includes a subdrain system as added protection against groundwater impairment. The subdrain system will collect and convey water away from the bottom of the liner and also prevents the development of pore pressure within the containment system in the unlikely event that groundwater seeps into the excavation or rises above its historical high level.

In addition, the liner system exceeds the prescriptive standard minimum and, therefore, by definition is consistent with the prescriptive standard of performance, and affords the equivalent protection against water quality impairment. As requested by the RWQCB, a liner demonstration analysis in support of the design was prepared and is included as Appendix H.

The design features for the lined waste management unit are described in Section C.2 and are shown on the design plans referenced in that section. In accordance with 27 CCR, Section 20310, the waste management unit was designed and the construction will be certified by a registered civil engineer and/or a certified engineering geologist.

The JTD sections that present the bottom and side slope containment system design (Section C.2) are formatted to present each liner system component from the subgrade to the operations layer (e.g., protective soil cover) as they would be sequentially constructed. Typical sections for the sideslope liner design which vary from the bottom liner design are also discussed. The total waste containment system includes the following elements:

- Excavation Plan (Subgrade Configuration)
- Subdrain System
- Liner System (including secondary drainage layer)
- Leachate Collection and Removal System
- Protective Layer (Operations Layer)

In addition, Section C.2 also presents information on the landfill gas collection/recovery and drainage control (both interim and final) systems and landfill construction sequencing. The GCLF engineering design also includes waste containment features to be implemented upon closure of a portion and/or the entire landfill. Part E of this JTD presents the closure design features for the GCLF.

The engineering plans are conceptual and reflect the design. Minor revisions to the engineering design may be necessary throughout the development of the landfill based on actual field conditions encountered prior to and/or during construction. The construction level design plans will be prepared to reflect actual conditions and be submitted to the RWQCB prior to construction of each phase or stage of waste containment system construction.

In addition, detailed as-built plans and quality assurance reports will be prepared and submitted to the RWQCB, upon completion of containment system construction for each area of development as required by 27 CCR, Section 21760.

The information presented herein satisfies the applicable regulatory reporting requirements under 27 CCR, Sections 21600 and 21760 related to the site's design. Tables 1 and 2, discussed in Part A, provide the necessary cross-reference information to find the appropriate subsections in Part C which correspond to the specific regulatory requirements under 27 CCR and 40 CFR, Part 258. As discussed in Section A.1.2, the Subtitle D Compliance Checklist is also included in Appendix A to allow dischargers and RWQCBs to assess compliance with Federal requirements (i.e., 40 CFR, Part 258).

SECTION C.2

PROPOSED DISPOSAL SITE DESIGN FEATURES

C.2 PROPOSED DISPOSAL SITE DESIGN FEATURES

C.2.1 INTRODUCTION

A description of the GCLF's disposal site design features is included in the following sections. The long-term development of the GCLF includes construction of a 183-acre refuse footprint. The three relocated SDG&E transmission lines are located along the eastern edge of the refuse footprint. The groundwater protection system for the GCLF refuse footprint will include a subdrain system, a composite liner system, an LCRS, and a protective layer. The GCLF will also be constructed with an interim and final surface water control system, as well as environmental control/monitoring systems. The GCLF will also be capped with a final cover system designed in accordance with applicable regulatory requirements. The proposed final closure design features and post-closure maintenance activities were developed in accordance with 27 CCR and are included in Parts E and F of this JTD.

All of the engineering plans reflecting the landfill are conceptual in nature and subject to change. The composite liner system design, which is a component of the overall waste containment system, exceeds the prescriptive standard design criteria specified in 40 CFR, 258.40. As required by 27 CCR, Section 21760, detailed as-built plans and quality assurance reports of the containment system will be prepared and submitted to the RWQCB, upon completion of containment system construction for each area of development.

C.2.2 EXCAVATION PLANS

C.2.2.1 GENERAL DESCRIPTION

In order to maximize site capacity, development of the GCLF refuse disposal area will include the mass excavation of a substantial volume of native materials. The excavation plan shown on Figure 12 presents final subgrade contours and limits of excavation. The overall interior slope gradient will be 2:1 and the flatter bottom areas will have a minimum gradient of 5 percent. As discussed in the following sections, once the excavation is complete, a subdrain system, composite liner system and LCRS will be installed. As noted earlier, the landfill will be constructed in phases and the construction sequencing is discussed in Section C.2.9.

C.2.2.2 STABILITY OF EXCAVATION SLOPES

Based on slope stability analysis recommendations provided in the geotechnical investigations (Appendix C), the subgrade contours will not exceed gradients of 1.5:1 between the interior benches and the overall interior slope gradient with benches will not exceed 2:1. The interior cut slopes will have benches 20 feet wide spaced no greater than 40 vertical feet apart. These benches will be graded with a 6.7 percent inward gradient toward the inside of the bench/toe of the upper slope interface. The interior benches will have a 3 percent gradient horizontally toward the mouth of the canyon.

Additionally, studies conducted by Woodward-Clyde Consultants (1995) concluded that 2:1 slopes adjacent to the aqueduct are appropriate with a factor of safety of at least 1.5 under static conditions and, therefore, the impacts on the aqueduct by the landfill are not significant. In response to concern about the stability of the first San Diego Aqueduct during an earthquake event, GLA also performed a pseudo-static analysis of the proposed east-facing cut slopes (adjacent to the aqueduct). Static analysis of modeled wedges indicates a factor of safety of 5.9. This means that the forces resisting movement are approximately six times greater than the forces causing movement. When subjected to ground acceleration associated with the Maximum Credible Earthquake (0.4g), the factor of safety also exceeds the prescriptive 1.5 dynamic factor of safety for all landfill foundation and final fill slopes required by 27 CCR.

C.2.2.3 MATERIAL AVAILABILITY

Assuming a 4:1 refuse-to-cover ratio, approximately 11.5 million cubic yards (mcy) of soil material will be needed for refuse disposal operations over the active life of the landfill. An additional 1.2 mcy of material will be necessary to provide final cover over the site. The landfill development will include the excavation of approximately 7.9 mcy of topsoils, alluvium/colluvium or weathered bedrock from within the landfill footprint that can be used for cover material. Excavated colluvium and weathered bedrock material will be stockpiled for use during the operation and closure of the landfill. Based on drilling conducted on the site, approximately 60 percent of the material excavated from the landfill footprint, or 3.9 mcy, could be used directly as cover material.

Overall development of the GCLF also includes removal of soil from two borrow/stockpile areas. Borrow/Stockpile Area A is approximately 22 acres and will be excavated to depths ranging between 10 and 65 feet below existing ground surface, to extract approximately 1.3 mcy of soil. Development of Borrow/Stockpile Area B (approximately 65 acres) calls for an excavation that will reach depths ranging from 70 to 150 feet below ground surface and extract approximately 3.2 mcy.

The entire excavated quantity will be available for cover needs since all of the material excavated from the borrow/stockpile areas will be colluvium and weathered bedrock. Therefore, approximately 8.4 mcy of material will be available for on-site cover, leaving a shortfall of readily useable material over the life of the project of 4.3 mcy (including final cover). This shortfall will be offset by on-site processing (i.e., rock crushing) or weathering of rock material and the use of geosynthetic blanket ADC. The use of ADC has been shown to reduce refuse-to-daily cover ratios from 4:1 to 7:1. Table 9A shows the daily/intermediate cover volume demands at both 4:1 and 7:1. The use of ADC could reduce the project demand for soil cover by as much as one-third. As can be seen on Table 9A, achievement of the 7:1 refuse-to-cover ratio will balance the site based on the availability of 8.4 mcy of soil within the refuse footprint and Stockpile/Borrow Areas A and B.

TABLE 9A
GREGORY CANYON LANDFILL
SOIL REQUIREMENT SCENARIOS

4:1 Daily/Intermediate Soil Cover Volume Requirement		
Net Volume (cy)	Refuse Volume (cy)	Soil Volume (cy)
57,500,000	46,000,000	11,500,000
7:1 Daily/Intermediate Soil Cover Volume Requirement with ADC		
Net Volume (cy)	Refuse Volume (cy)	Soil Volume (cy)
57,500,000	49,285,714	8,214,286

Based on gross air space of 60.0 mcy and net air space of 57.5 mcy

Geosynthetic blankets (an approved ADC under 27 CCR, Section 20690), in conjunction with soil, are expected to be used at the onset of refuse disposal operations at the landfill.

C.2.2.4 STOCKPILE/BORROW AREAS

As discussed above, approximately 87 acres of borrow/stockpile area will be provided in two locations (Figure 2). Borrow/Stockpile Area A, which is about 22 acres in size, will be located west of the landfill footprint (adjacent to the western property boundary). Borrow/Stockpile Area B, which is about 65 acres in size, will be located immediately southwest and adjacent to the landfill footprint. The maximum height of the Borrow/Stockpile Area B ranges from about 940 to 1,020 feet amsl. For borrow purposes, excavation in the designated areas will be a maximum of 150 feet and positive drainage will be maintained.

GLA reviewed the stability of the cut slopes in the borrow/stockpile areas, and calculated static factors of safety ranging between 2.10 and 4.04 for six critical sections. The pseudo-static factors of safety for these sections ranged from 1.50 to 2.89 for a seismic coefficient of 0.15. The latter values are equal or larger than the threshold factor of safety of 1.5 required by 27 CCR.

The borrow/stockpile areas will be used to store and provide cover material for refuse disposal operations at the landfill. During the initial excavation of the Phase I area of the refuse footprint, a portion of the excavated material will be used for engineered fill necessary to construct the ancillary facilities area and the toe buttress at the very northern end of the overall refuse area. The remainder of the excavated material will be stockpiled in the landfill footprint or Borrow/Stockpile Area A. Borrow/Stockpile Area A will be used for stockpiling or excavated material during the initial construction after which the area will be graded to promote proper drainage, and then revegetated with native plant species. Borrow/Stockpile Area A will then not be used again until about year 25 at which time material will be removed from Area A and utilized for cover. In subsequent excavation phases, material will be stockpiled within the footprint or in Borrow/Stockpile Area B.

The borrow/stockpile haul road, connecting Borrow/Stockpile Area A with the landfill footprint, will be 20 feet wide and will run along the base of the adjacent hillside with turn-out locations for heavy equipment at three points along the route. Most of the alignment of the haul road follows an existing dirt road on the site. Borrow/Stockpile Area B is located immediately southwest and adjacent to the refuse footprint, therefore, access will be gained directly from the refuse area footprint. The maximum slope of the borrow/stockpile haul roads will be 15 percent. Equipment moving between the borrow/stockpile areas and the landfill will cross over the First San Diego Aqueduct. Two reinforced concrete slabs will be placed at grade, one centered over each pipeline. Each two foot thick slab will be 28 feet wide by 40 feet in length placed on top of a layer of polystyrene. The three to four foot deep soldier beams at each end of the slab will absorb the weight of the equipment as it crosses the aqueduct.

Proper drainage control will be maintained in the borrow/stockpile areas. Surface water control features will include grading of the flatter deck areas to promote lateral runoff of precipitation into drainage control facilities such as downdrains and bench drains on the slopes. Surface waters will be conveyed from the borrow/stockpile areas and discharged into the existing natural drainage courses. Erosion control measures such as vegetation, desilting basins, sand bags, straw matting and/or rip-rap will be utilized to reduce downstream siltation potential.

Borrow/Stockpile Area B will drain to the southwest into a natural drainage course. The drainage course for Borrow/Stockpile Area A runs northwesterly. The drainage control facilities will direct the surface water runoff into the existing streambeds. At the western end of the Borrow/Stockpile Area B, a desilting basin will be constructed to minimize the flow of silt from the borrow/stockpile area. The desilting basins will be designed to accommodate the soil loss from the borrow/stockpile areas. The pre-developed drainage condition of the area will be maintained as closely as possible once operations are discontinued in each of the borrow/stockpile areas. Discharge rates will be equal to or less than natural flow conditions.

In addition, the borrow/stockpile areas will also be revegetated with native plant species to return these areas to a more natural state. Construction and operation of the borrow/stockpiles including the drainage facilities will be conducted in accordance to the BMPs developed as part of the SWPPP included as Appendix D. The SWPPP is required to comply with State and Federal regulations under the NPDES program. The NPDES permit encompasses all federal guidelines regarding the discharge of stormwater.

C.2.3 SUBDRAIN SYSTEM

As currently designed, the necessary groundwater separation will be achieved by constructing the bottom subgrade at a minimum of five feet above the highest anticipated groundwater level. In addition, the composite liner system, LCRS and operations layer provide even more separation between the highest groundwater level and refuse.

Even though the GCLF bottom grades are a minimum of five feet above the piezometer surface and therefore, groundwater is not anticipated, a subdrain system is proposed to be constructed beneath the GCLF waste containment system in floor areas. The subdrain system will collect and control any groundwater, if it intersects the subgrade excavation along the bottom.

The subdrain system for the GCLF will be placed beneath the composite liner and will consist of a one-foot thick gravel blanket and gravel filled trenches with slotted collector pipes in the floor areas. The floor subdrain system is designed to be a redundant system in which the permeable gravel pack and the pipe can both convey over a million gallons of water per day. A geotextile layer separates the gravel layer from the low-permeability soil layer on the landfill floor. This geotextile layer prevents the floor subdrain from clogging. Figure 13 shows the proposed layout of subdrain pipe design. Cross sections of the subdrain system on the bottom area are shown on Figures 14, 15, and 15A.

As a contingency, in the event that localized groundwater seeps are encountered in the canyon and/or the proposed cut slopes, the water will be managed. Seeps encountered above the active development areas will be directed into the perimeter surface water control system (i.e., perimeter channels). In this event, the design also includes provisions for a subdrain system beneath the composite liner over the slope areas.

The seeps will be measured for flow volume to determine the exact design of the subdrain collector. Once liner construction reaches the observed seep elevation, a localized subdrain system will be installed. The subdrain feature utilized will be a chimney drain. Based on seep flows, the chimney drain will be constructed consisting of either a geonet or trench-type collector. A geonet strip collector will be constructed and used for lower flow seeps. The collector will be placed from the seep to the next lower bench into a section of slotted pipe surrounded with gravel and wrapped in geotextile. The slotted pipe will transition to solid pipe gravity flowing to the floor area subdrain system. Higher flow seeps may warrant a trench collector type chimney drain. A trench will be cut into the side slope from the next lower bench up to the seep. The trench will be filled with gravel and wrapped with geotextile. A perforated pipe can also be added for additional flow capacity. The trench size will be dictated by flow rates. The trench collector will connect at the bench and eventually to the floor subdrain system similar to the geonet collector.

The subdrain system discharge will be monitored for contamination in accordance with the WDR parameters. Any contaminated water will be treated at the landfill as discussed in B.5.1.8 or transported to an appropriate off-site disposal facility.

C.2.4 LINER SYSTEM DESIGN

As discussed above, the composite liner system to be installed at the GCLF exceeds the prescriptive design standards required by 40 CFR 258.40. As discussed earlier, a liner demonstration in support of the design was prepared and is included in Appendix H. The liner system design for the GCLF consists of the following components:

- **Bottom Liner System Design.** The bottom area liner section will include (from top to bottom): a minimum 24-inch thick protective soil cover layer, a 12-ounce non-woven geotextile, a 12-inch thick LCRS gravel layer, a 16-ounce non-woven geotextile, an 80-mil HDPE geomembrane (textured on both sides), a non-woven geosynthetic clay liner (GCL), a 60-mil HDPE geomembrane (textured on both sides), a 16-ounce non-woven geotextile, a 9-inch minimum thickness gravel or equivalent drainage layer (including collection pipe), a 16-ounce non-woven geotextile, a 60-mil HDPE geomembrane (textured on both sides), and a 24-inch thick layer of low-hydraulic-conductivity material ($<1x10^{-7}$ cm/sec) placed over the subdrain system (see Section C.2.3) with a 12-ounce non-woven geotextile between the low-permeability layer and a 12-inch thick layer of subdrain gravel. Figure 14 presents a typical cross-section of the bottom liner system design.

- **Slope Liner System Design.** The slope liner system design (e.g., sections with gradients greater than 5:1), will include (from top to bottom): a protective soil cover layer (minimum of 24-inches thick), a 16-ounce non-woven geotextile, an 80-mil HDPE geomembrane (single-sided textured, textured side down), a non-woven GCL, a 60-mil HDPE geomembrane (textured on both sides) and a 24-inch thick layer of low-hydraulic-conductivity material ($<1x10^{-7}$ cm/sec) placed over the subdrain system placed over a localized subdrain system, as needed (see Section C.2.3). Figure 14 presents a typical cross-section of the slope liner system design.

- **Geosynthetic Materials.** At present, two types of geosynthetic materials are to be used in the construction of the liner system. These include:
  - **Geomembrane.** 40 CFR 258.40 specifies a minimum geomembrane thickness of 30 mils, unless HDPE geomembrane is utilized. If HDPE geomembrane is used, the minimum required thickness is 60 mil. The design proposed for the GCLF will utilize a 60-mil HDPE geomembrane liner.
  - **Geotextiles.** Although geotextiles are not required by regulation, geotextiles will be used in the GCLF liner system to minimize fine-grained material particle migration from the liner and protective soil layers into the various underlying subdrains and LCRS drainage layers and to provide cushioning protection to the HDPE geomembranes.

- **Soil Liner Component.** Liner construction will be monitored under extensive Construction Quality Assurance (CQA)[1] guidelines. The material for the low-permeability liner will either be imported to the site, most likely from the Lake Elsinore area, or be prepared by using on-site material blended with imported bentonite to achieve the desired low-permeability performance criteria. Approximately 530,000 cubic yards of low-permeability material will be needed for the slope liner and 125,000 cubic yards for the floor liner.

With respect to long-term performance of the liner, the proposed composite liner system will have excellent durability and is expected to have an effective life that exceeds the time period in which leachate and gas would be produced in the landfill. The design and operational procedures for the landfill will prevent the HDPE geomembrane from being exposed to unacceptable mechanical or chemical stresses. Under these conditions, the life of the geomembrane should be on the order to hundreds of years.

In a recent paper, Hsuan and Koerner (1998) looked at the depletion of the antioxidants in HDPE geomembranes, the first stage in a three-stage process of geomembrane degradation. Antioxidants are added to the HDPE geomembrane formulation to prevent oxidation during extrusion and to provide long-term

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[1] CQA assures that construction material will be tested, installed and monitored as specified in the design plans and specifications, and that accepted civil engineering practices will be used.

service life to the product. Based on accelerated laboratory simulation testing over a period of 24 months and modeling to extrapolate the antioxidant lifetime to a typical landfill site at 20 degrees C, the predicted time was 200 to 215 years for this first stage of geomembrane degradation alone. During the testing period, additional testing of the incubated materials indicated that the physical and mechanical properties remained unchanged.

Construction of the liner system will be conducted in accordance with a CQA plan prepared in compliance with 27 CCR, Sections 20323 and 20324, and certified by a registered engineer or a certified engineering geologist. The CQA plan includes selected testing, inspection and documentation of the final construction product in order to provide the Owner/Agencies with an evaluation of whether the end product is of the specified quality of materials and workmanship. A CQA plan for the liner construction is provided in Appendix N.

C.2.5 LEACHATE COLLECTION AND REMOVAL SYSTEM

C.2.5.1 GENERAL DESCRIPTION

The containment system design for the GCLF includes a LCRS above the liner to collect and convey leachate that may be generated within the refuse prism. The LCRS has been designed on the basis of maximum anticipated leachate generation for the disposal area. The general LCRS design will consist of a granular (gravel) drainage blanket (one foot thick) constructed immediately above the liner in the bottom liner areas. A network of leachate collection pipes placed within the granular (gravel) drainage blanket will convey accumulated fluid by gravity flow to the mouth of the canyon to be discharged into two double-walled collection tanks. The LCRS system has been designed to prevent clogging of gravel and the pipe layer. Figure 13 shows the proposed layout of the leachate collection pipes.

The LCRS design over slope liner areas consists of gravel pipe collectors wrapped with a geotextile filter fabric placed on the interior benches along the slopes. The LCRS details are provided in Figures 14, 15 and 15A.

C.2.5.2 DESIGN CRITERIA AND OBJECTIVES

The design criteria for the LCRS are based on current State (27 CCR, Section 20340) and federal (EPA Subtitle D) regulations for municipal waste landfills. These criteria result in a conservative design that includes:

- Maintaining leachate levels at one foot (30 cm) or less at all points over the composite liner system;
- Design of a system capable of collecting and removing twice the anticipated maximum daily volume of leachate from the cells;
- A minimum gradient of one percent in the mainline; and
- Long-term, maintenance-free performance compatibility in the leachate environment and under the expected maximum landfill loading conditions.

In addition to the above-mentioned criteria, the LCRS is designed in accordance with the following objectives:

- To rapidly transport collected leachate from the collection point to the discharge;
- To maintain a reasonable and effective collection pipe spacing over the landfill base; and
- To maintain a pipe orientation that generally crosses the predominant leachate drainage direction on the cell floor to generate the maximum possible system redundancy and collection efficiency.

These objectives were used to reduce the amount of time that leachate remains on the liner, thereby, reducing the potential for migration of leachate through the liner system.

C.2.5.3 LEACHATE GENERATION

C.2.5.3.1 ANTICIPATED LEACHATE VOLUME

Modeling of potential leachate generation was performed for the GCLF using the United States Army Corps of Engineers Hydrologic Evaluation of Landfill Performance Version 3 (HELP3) computer program, which uses representative rainfall and evapotranspiration data to estimate leachate quantities that may be generated within the refuse prism. The program takes into account the total area landfilled, representative precipitation patterns, representative site evapotranspiration, and the hydraulic conductivity of various construction materials to calculate the estimated leachate generation and accumulation. Unsaturated flow is approximated in HELP3 using a material-dependent coefficient in its flow calculation. The leachate generation analysis performed for the GCLF is included in Appendix C.

Modeling indicates that the leachate generation will peak at approximately 1,236 cubic feet per day. A maximum 500-foot leachate collection pipe spacing for the floor areas and a maximum 100-foot drain spacing in the slope liner areas was recommended. These parameters will be adjusted to limit liquid build-up on the liner to the levels allowed by current regulations. The peak head of leachate over the liner based on the LCRS design was calculated to be 0.25 inches until the final cover is placed, after which leachate generation is expected to decrease significantly (to almost zero).

C.2.5.4 LCRS DESIGN

Due to the relatively flat grade along the base liner system, a minimum one foot thick gravel layer will be required over the majority of the bottom liner areas to keep the leachate head to less than 12 inches. In addition, the bottom base gravel blanket will host perforated LCRS lateral collectors and mainline pipes that will lead to the leachate outfall. The outfall pipe will discharge to two 10,000-gallon leachate collection storage tanks located in the southwest corner of the ancillary facilities. The LCRS pipes will be placed in V-shaped gravel trenches constructed within the top of the liner system. To minimize the potential for clogging, bio-fouling and piping, 85 percent of the gravel will be larger than the diameter of the perforations in the pipe. The bottom area LCRS gravel pack will be overlain by geotextile fabric to prevent clogging of gravel from the operations layer soil material.

Details of the pipe designs will be prepared prior to construction of the individual landfill phases. Based on preliminary analysis, it is anticipated that an HDPE pipe with a six-inch inside diameter and a sidewall to diameter ratio (SDR) of 11 will be adequate to carry the anticipated liquid volume and resist crushing under the anticipated refuse loads.

Regulations require that the LCRS layer extend up the side slopes of the excavation. However, a 12-inch thick gravel layer will not be constructed on slope because it could not be kept stable. Rather, the LCRS design for those areas with a slope gradient of 5:1 or steeper will consist of a permeable drainage gravel pack surrounded or wrapped with a geotextile fabric placed over the liner at the toe of the interior cut slope benches. Any leachate contacting the slopes will flow along the operations layer/refuse-interface to the bench collectors. Slotted HDPE pipe will be placed in the gravel pack to allow for liquid collection and distribution to the LCRS mainlines (see Figure 15).

Annual testing methods and procedures for the performance of the LCRS are discussed in Section B.5.1.1.2.

C.2.5.4.1 ACCESS RISERS AND LEACHATE EXTRACTION

Solid HDPE pipes will be used as risers to connect the perforated pipe sections from the main line to the benches and eventually to a LCRS outfall located at the point of discharge. The risers will ultimately daylight to the top of the refuse prism can also be used as access ports to afford cleaning of the LCRS pipes (see Figure 15). Leachate will flow from the outfall to two above ground tanks with a minimum storage capacity of 20,000 gallons. The storage tanks will be monitored for the presence of liquid by the operator during the routine quarterly sampling events or as specified by the WDR's.

C.2.5.5 LEACHATE TREATMENT/DISPOSAL

Leachate collected in storage tanks will be transported off-site for treatment and disposal. There are facilities located in San Diego and Los Angeles Counties that could dispose of the project-generated leachate. Alternate uses of the collected leachate will be approved by the RWQCB.

C.2.6 OPERATIONS LAYER

An operations layer (or protective soil layer) will be placed over the LCRS in the bottom liner area and all slope liner areas (see Figure 14). The operations layer is placed over the liner system to provide protection from waste materials, which may damage or puncture the upper liner component. The operations layer will consist of a maximum two-foot thick sand or soil layer. A geotextile fabric layer will be placed over the LCRS gravel on the bottom area prior to placement of the operations layer.

C.2.7 LANDFILL GAS EXTRACTION/RECOVERY

C.2.7.1 GENERAL DESCRIPTION

The landfill gas control system will consist of a series of vertical gas extraction wells joined through a system of above ground lateral pipes, which will be connected to a main header pipe leading to the flare station. The entire system can be divided into three main subsystems; the landfill gas extraction well field; the landfill gas conveyance lines and then the landfill gas treatment facility (generally a landfill gas flare). In addition to the landfill gas extraction/recovery system, a perimeter landfill gas migration monitoring network will also be installed.

Once the gas control system is installed and operational, the landfill gas flare station will be the primary method for disposing of the collected gas. The flare station will be located near the site facilities area (Figure 8). Liquid condensate collected from the landfill gas system will be incinerated in the flares, treated on-site, and if necessary, removed off-site for disposal.

C.2.7.1.1 VERTICAL GAS EXTRACTION WELLS

A number of vertical gas extraction wells will be installed to maintain compliance with applicable regulations for gas migration and surface emission control. A typical vertical gas extraction well will have a variable diameter, generally perforated PVC casing set in a gravel backfill. The well casing will vary in diameter depending on the depth of the well, and each well will transition from perforated pipe to a minimum of a ten-foot section of solid pipe near the surface sealed with a grout material. The vertical wells installed at the GCLF will be placed to the maximum depth possible without penetrating the bottom of the landfill. A wellhead assembly consisting of sample ports and a flow control valve will be installed to allow for monitoring and tuning of the wells. The wellhead assembly may also include a pitot tube port to monitor flow. Figure 16 shows a typical vertical gas collection well. Figure 16A presents details for both single and dual gas extraction well connections.

C.2.7.2 LANDFILL GAS SYSTEM FACILITIES AND OPERATION

The proposed conceptual layout of the landfill gas control system is shown on Figure 11. This system was developed based on the anticipated gas generation and reflects the associated number of wells required at the GCLF. However, the actual number of extraction wells will be dictated by landfill gas generation conditions observed as the landfill is developed (e.g., results of subsurface and surface monitoring performance). Due to the varying depths of refuse, the unknown nature of the waste composition and associated gas generation potential, the final spacing of the extraction wells may be modified, as needed, to accommodate actual site conditions and meet San Diego APCD standards.

During active operations, gas extraction wells will be installed incrementally to provide ongoing environmental control. The extracted gas will be transported to the flare station through gas headers. The number of flares required will depend on the amount of landfill gas the site generates and whether or not future operations include a use for the gas other than flaring. Typically, flare stations are expanded in phases to process the additional landfill gas flow and it is anticipated that up to four 1,500 scfm flares may be necessary to handle gas destruction at the GCLF, once peak landfill gas production is reached.

Condensate which forms in the gas system piping will gravity drain to sumps placed at low-points in the system around the landfill. The collected condensate will be removed from the sumps manually or will be pumped automatically to a central holding tank located near the flare station. Liquid condensate collected from the landfill gas system will be incinerated in the flares, treated on-site, and if necessary, removed off-site for disposal.

It is anticipated that the entire gas control system will be installed prior to closure and that minimal additions/modifications to the system will be necessary at closure. During closure construction, the system will be taken off-line in phases (as the final cover system is placed), modified appropriately and then reconnected.

C.2.7.3 GAS MIGRATION MONITORING

Landfill gas migration monitoring probes will be installed in native soils around the perimeter of the GCLF to monitor for possible subsurface migration. It is anticipated that a total of 16 probes will be installed at multiple depths on 1,000-foot centers around the entire refuse prism (see Figure 2). These probes will be sampled at a minimum on a quarterly basis to determine if landfill gas is migrating away from the landfill. When compliance levels are exceeded in any probe, adjustments to the gas system will be initiated and/or additional extraction wells will be installed.

Generally, the landfill gas migration probes are installed at or near the disposal site property boundary to comply with 27 CCR, Section 20925(a)(2). However, due to the large area of property encompassed by the GCLF, the severe changes in topography, the fractured nature of the material underlying the site and the cost of probe installation and monitoring, the majority of the probes will be installed in natural ground around the refuse footprint.

C.2.8 DRAINAGE CONTROL

C.2.8.1 GENERAL DESCRIPTION

The surface water drainage control systems (both interim and final) for the GCLF are designed to accommodate 100-year, 24-hour storm event run-off volumes. Surface water drainage control at the site will be handled by two separate systems, one collecting and conveying water from undisturbed areas and the other collecting and conveying water from disturbed areas. The system for undisturbed areas will collect and convey run-on from the surrounding areas as well as runoff from the undisturbed areas within the refuse footprint. This system will consist of above ground perimeter drainage channels (i.e., the eastern and western perimeter channels) and energy dissipaters. The disturbed area system includes deck and slope area grading, earthen berms and downdrains all set to discharge to buried perimeter drainage pipes, which empty to the desilting basins.

In addition, the western perimeter channel was also sized to accommodate the volume of water caused by a simultaneous rupture of the existing Pipeline Nos. 1 and 2 and the future Pipeline No. 6 at the same time as a 100-year, 24-hour storm event. Interim drainage control features and procedures will be instituted during active disposal operations and will include fill area grading, downdrains, earthen berms and desilting basins. Some of the interim drainage control system facilities (e.g., desilting basins) will be utilized as part of the final drainage control system for the site.

The final drainage control system includes exterior slope downdrains, engineered deck area gradients and drainage berms, deck inlets, bench drains and inlets, perimeter drainage pipes, trapezoidal perimeter channels and two desilting basins. The following discussion outlines the methodology that was used to design and analyze the drainage control system for the GCLF. The final drainage control system configuration is shown on Figure 17.

C.2.8.2 HYDROLOGY

A hydrology study was conducted to evaluate future surface water drainage conditions at the site in accordance with 27 CCR, Section 20365. The objective of the hydrology study was to provide sizing and location information for the site's storm drain facilities based on the final fill configuration.

The Rational Method was used for the calculation of the peak discharge of a 24-hour, 100-year storm event. As discussed above, the western perimeter channel is sized to accommodate a rupture of existing Pipelines 1 and 2 and future Pipeline No. 6 at the same time. In addition, the refuse fill slopes east of the western perimeter interceptor channel may be armored to prevent the runoff from a rupture from destroying the cover material and exposing trash. It should be noted that the SDCWA aqueduct is planned to be relocated to the west away from the refuse footprint; thereby minimizing potential impacts from a rupture. As a result, the size of the perimeter drains could be reduced if the aqueduct is relocated. Estimated run-off values were calculated based on the most current San Diego County Hydrology Manual (2003 version) in conjunction with computer software developed by Advanced Engineering Software (AES). The hydrology study map for on-site flows is shown on Figure 18. Hydrology/hydraulics analysis is contained in Appendix I and the drainage system sizing calculations, including the desilting basins, are contained in Appendix J.

C.2.8.3 DRAINAGE CONTROL SYSTEM

C.2.8.3.1 ON-SITE DRAINAGE FEATURES

On-site drainage features were designed and will be constructed to control stormwater that falls on the landfill and run-on from the surrounding watershed. Stormwater on the landfill deck will sheet flow until it is intercepted by berms located along the edges of the deck. The deck berms will direct flows to downdrains. Exterior benches will collect stormwater from the up gradient slope and divert flows to the bench downdrain inlets. The downdrains will be perpendicular to slope contours and located atop, and anchored into, the final landfill surface. Downdrains will be extended up completed side slopes of the landfill as the filling progresses and also accommodate inlets at each bench. The gradient of these downdrains will follow the surface of the refuse slope and will maintain a minimum three percent grade across the benches. The downdrains will outlet into buried perimeter drainage pipes located adjacent to the open channel storm drains discussed below. The buried pipes will discharge into the desilting basins. The buried storm drain pipes will be outfitted with manhole access pipes placed approximately every 300 linear feet and at major grade breaks and sharp angles to provide access and maintenance. The manholes will be covered with lids which can be locked. Inspection of the buried storm drain pipes will be conducted on a routine basis. Any blockage observed will be jetted away with high pressure water or other standard cleaning methods. The desilting basins will reduce the amount of silt ultimately discharged from the landfill site. Figure 19 shows the drainage control system details.

C.2.8.3.2 PERIMETER STORM DRAIN (PSD) SYSTEM

The PSD system will consist of a reinforced concrete trapezoidal drainage channels placed around (outside) the refuse footprint. A portion of the eastern channel will be constructed during the initial construction phase (Phase I) to accommodate flows from the upper eastern slopes of the canyon. Earthen berms will also be used to divert run-on from adjacent slopes and the up-canyon areas of the undisturbed footprint into the perimeter storm drains. Construction of a portion of the western perimeter channel along the lower portion of the canyon will be installed concurrent with the initial construction phase (Phase I) to divert run-on from the east facing slopes, west of the footprint.. The PSD channels will be completed moving up canyon as the landfill is developed. The PSD is intended to control run-on (from adjacent areas to the landfill) that might otherwise flow onto the landfill. The stormwaters conveyed by the PSD system will discharge directly to the natural drain courses at approximately the same discharge point as the eastern and western desilting basins, located near the ancillary facilities. Energy dissipaters will be utilized to match pre-development flow velocities. A PSD detail is shown on Figure 19.

The western perimeter trapezoidal channel crosses the existing First San Diego Aqueduct easement as it flows to its discharge point. At this location, the perimeter channel will have a cut-off wall on the upstream and downstream side of the crossing to prevent water from undermining the aqueduct. The crossing will be reinforced with extra concrete and steel.

C.2.8.3.3 OTHER STORM DRAIN FACILITIES

Intermediate deck drains and downdrains will be required, extended and upgraded as waste filling progresses, or as required, to satisfy the ultimate design presented in the final drainage plan.

C.2.8.3.4 STORMWATER DESILTING BASIN

The primary function of a desilting basin is to collect and store sediment before it can be transported offsite. However, desilting basins are passive systems that rely on settling soil particles out of the water in a finite time period, and are not 100 percent efficient in entrapping sediment. Therefore, desilting basins are typically only designed to function as a secondary system to help minimize transport of sediment offsite. The primary erosion control measures are BMPs which are designed to control sediment transport at the source. The use of BMPs and their use throughout disposal operations are discussed in Section C.2.8.3.5, below.

When designing desilting basins, the capacity is based on the potential volume of silt generated from the contributing watershed area which is determined based on the Universal Soil Loss Equation (USLE). One of the coefficients in the USLE is an empirical value that is a summation of individual storm products of the kinetic energy of rainfall, in hundreds of foot-tons per acre, and the maximum rainfall intensity, in inches per hour of all significant storms on an average annual basis. As discussed above, the GCLF is designed to include two separate drainage control systems, one to handle storm water flows from surrounding areas and undisturbed areas within the refuse footprint, and the second to handle run-off from the disturbed areas within the refuse footprint. Therefore, only flows from the disturbed areas within the refuse footprint would be directed to the desilting basins, dramatically reducing silt potential.

J. Ateshian empirically derived an equation in 1974 (as a supplement to the USLE), which is applicable for Southern California. The equation ($R=16.55xP^{2.2}$) utilizes 2-year, 6-hour rainfall data (P), and the product R is used in the USLE equation to estimate potential silt volumes. The author empirically determined that the 10-year, 6-hour rainfall event most closely models the average rainfall event that watersheds will experience, year after year. This model yields the best estimate of potential sediment deposits in a particular desilting basin on an annual basis.

The 10-year, 6-hour rainfall data along with a 0.02mm particle size was used to calculate the efficiency of the desilting basins. Additionally, the 10-year, 6-hour storm event criteria was utilized as recommended by the California Storm Water Best Management Practice Handbook. The 0.02mm entrapment particle size was based on site conditions. These factors were considered acceptable by the RWQCB as the project design basis. Utilizing this particle size, the calculated efficiency of the basins would be approximately 75 acres of disturbed landfill area at any given time over the life of the project. The results of the basin efficiency calculations are included in Appendix J. The following design criteria/parameters were utilized:

- maximum area of disturbed acreage for three particle sizes were calculations of 0.01, 0.02, and 0.05;
- the Rational Method Hydrology Computer Model run for the 10-year, 6-hour storm event;

- Table 8.1 of the Erosion and Sediment Control Handbook showing settling velocities for various grain sizes; and
- ACOE information.

The 0.02mm grain size and resulting calculations are considered to be conservative because the excavated side slope areas will consist primarily of hard rock and will contribute very little if any sediment to the basins.

The desilting basins will be located just east and west of the ancillary facilities (see Figure 17). The grading plans for the eastern and western desilting basins are shown on Figure 20. The desilting basins are intended to control the amount of silt ultimately discharged from the landfill as well as the rate of discharge. The basins are designed to settle out material in the coarse silt range and will not retain water. Table 9B presents some of the characteristics of the desilting basins.

The eastern desilting basin will outflow directly into the San Luis Rey River. The western desilting basin will also outlet to the river. However, if the aqueduct easement is relocated further west and pipelines are moved west, then the western desilting basin will discharge to a pipe located at the access road crossing to reduce the number of structures crossing the aqueduct easement. The desilting basins will be constructed during initial refuse liner construction with Phase I.

TABLE 9B
GREGORY CANYON LANDFILL
CHARACTERISTICS OF DESILTING BASINS

Characteristic	Eastern Desilting Basin	Western Desilting Basin
Acres	1.8 acres	3.7 acres
Length	375 feet	675 feet
Width	350 feet	250 feet
Depth	20 feet	20 feet
Capacity	15 acre-feet; 32,500 tons of silt	18.4 acre-feet; 40,000 tons of silt

Source: Bryan A. Stirrat & Associates, 1999
Refer to Appendix J for desilting basin calculations.

Before each rainy season, after each major storm and monthly during the rainy season, all drainage facilities will be inspected and any required maintenance performed to ensure that the drainage channels and desilting basins function properly. Any silt collected in the basins will be used as daily cover.

C.2.8.3.5 EROSION CONTROL PLAN

Site operations will utilize a number of erosion control improvements to minimize transport of sediment offsite. By analyzing existing topographical and design maps, the areas most prone to erosion were identified. Best Management Practices (BMPs) will be implemented to control and minimize transport of sediment off-site. In addition, BMPs utilizing the Best Available Technologies that are an economically achievable will also be considered. The BMPs will focus on erosion control measures discussed below in conjunction with the interim and final drainage control features discussed in Section C.2.8.3. Applying these practices will protect the soil surface and prevent soil particles from being detached by rainfall or wind. As a secondary means of controlling sediment transport, desilting basins are also proposed.

The natural geologic conditions at the site will act as a type of BMP. For example, the exposed slope faces in the excavation areas will be largely hard rock material that in some instances may require blasting. This type of material is not erosive and storm water runoff from these areas will carry little if any sediment.

For those areas disturbed and consisting of alluvial material, sediment transport from the landfill cover will be greatly reduced by the use of the BMPs discussed below.

To maintain the integrity and effectiveness of the BMPs, inspection and maintenance protocols will be implemented. Inspection of the BMPs will be conducted and documented on a regular basis and maintenance repairs will be performed based on these routine inspections and on an as-needed basis.

Down drains are proposed as part of the BMPs to intercept surface water from the deck area and slope areas and to facilitate rapid removal of runoff from the landfill. The down drains will reduce the runoff concentrations on unprotected areas of the waste prism, thereby minimizing erosion. The down drains are proposed at an average of 600-foot intervals to intercept runoff flows from the deck and benches before their flow velocities become erosive.

To further reduce silt loading, only storm water flows from disturbed erodable areas within the refuse footprint will be allowed to discharge into the basins. To accomplish this objective, the surface water control system includes the addition of a separate buried pipe system installed along the perimeter of the refuse footprint, which would redirect runoff from only disturbed areas (a maximum of 75 acres) from within the refuse footprint and into the debris basins.

All run-on from surrounding areas and the undisturbed areas of the site would be captured by the perimeter drainage channels and discharge downstream of the landfill. These storm water flows would be discharged utilizing energy dissipaters to match pre-development velocities and run-off peaks. Figure 17 presents a layout of the drainage control systems and Figure 18 is an updated Hydrology Map showing the sub areas consistent with the utilization of two perimeter drainage control system features.

In addition to the drainage control system, the site will be operated with a combination of BMPs including erosion control mats, mulching, and hydroseed to promote the establishment of a vegetative barrier to minimize exposure of soil from the elements.

In addition, coir logs, straw wattle, and straw/hay bale check dams will be installed to reduce flow velocities within the watershed. The erosion control mats and mulching will provide a temporary barrier to intercept energy from rainfall and prevent soil particles from being detached until the hydroseeded vegetative barrier is established. These erosion control mats will be installed on the slopes and the decks of the landfill.

One of these BMPs will include the establishment of native vegetation on intermediate or final fill areas of the landfill. Once an area of the landfill is completed and native vegetation reaches a state of 70 percent coverage (based on pre-development conditions) then storm water flows from that area will be diverted into the perimeter drainage channels, which will not discharge downstream into the desilting basins.

An additional benefit to the buried perimeter drainage pipes utilized for the disturbed areas is that they can be reactivated during the post-closure maintenance period. Any routine cover repairs, which result in significant disturbance to the ground surface, may cause silt loading. Therefore, until native vegetation is re-established, any storm water will be discharged to the basins.

Figure 21 presents the Phase I Fill Plan showing the anticipated location and types of BMPs that may be utilized to control storm water flows at the beginning of landfill operations. Figure 21A presents BMP details and sections.

C.2.9 LANDFILL CONSTRUCTION PHASING

C.2.9.1 INTRODUCTION

Incremental landfill phase configurations are based on the fill sequencing anticipated over the life of the landfill. The following sections describe the rationale for the phase configurations as well as the anticipated excavation, grading, liner and LCRS, waste fill, drainage control, and infrastructure development. The development sequence is based on the excavation plan, ultimate fill plan, and established design criteria.

The project includes some modifications to improve sight distance and to facilitate truck movements on Pala Road (SR 76) near the access road entrance. These activities will be completed in conjunction with the construction of the main access road and bridge.

The on-site and off-site stormwater drainage control facilities and the GCLF infrastructure for the ultimate configuration are intended to be constructed progressively as waste filling is completed. Interim drainage and erosion control structures will be constructed and periodically relocated as waste filling progresses until final grades are reached. This will provide continuous stormwater collection and conveyance in a controlled manner and minimize erosion, ponding, and the potential for excess leachate generation and surface water contamination.

Phases I and II constitute the majority of excavation during the GCLF's development and as a result, stockpile areas have been designated to accommodate these soils until used for cover operations and/or other uses. Material excavated within the refuse footprint will be stockpiled in the areas designated as Borrow/Stockpile Area A and/or Borrow/Stockpile Area B. The stockpile locations will be west of the footprint area (Borrow/Stockpile Area A) and immediately southwest and adjacent to the footprint area (Borrow/Stockpile Area B) (see Figure 2). Up to approximately 9.4 mcy of soil can be stockpiled in these areas. The total volume of materials estimated in each phase was calculated using the contour method. This method involved estimating the enclosed area of each contour within the topographic and/or grading plan boundary, computing the volume contained between adjacent contours, and summing the individual volumes into a total volume. Definitions and assumptions are provided below. For additional information on material availability, refer to Section C.2.2.3.

It should be noted that the following fill sequencing discussion is based on the design which includes four excavation and three fill phases. Depending on actual refuse inflow rates over the course of active fill operations, each excavation/fill phase will be broken down into a number of actual construction stages.

C.2.9.1.1 DEFINITIONS

- Excavation Total: The total volume of excavation between the excavation plan surface and the existing ground surface (topographic map dated 1991).
- Gross Airspace: The total airspace volume contained between the excavation plan surface and the final fill plan surface.
- Containment System: The total volume of the containment system on the bottom and side slope areas. The volume of the liner system and LCRS is estimated by multiplying the assumed thickness by the total surface area.
- Final Cover: The total volume consumed by the final cover system on the deck and side slope areas. The volume is estimated by multiplying the proposed cover thickness by the surface area. The final cover system thickness may change with the approval of an alternative cover.
- Net Airspace: The volume available for daily operation. The net airspace is estimated as the gross airspace less the volumes of the containment system and final cover system.
- Daily and Intermediate Cover: The volume of soil required for daily and intermediate cover of the refuse.
- Waste Volume: The volume of net airspace less the volume of daily and intermediate cover.
- Phase Life: The operational life, in years, of the phase is estimated by dividing the available waste volume by the annual disposed volume.

C.2.9.1.2 EXCAVATION

As previously discussed, development of the GCLF will begin with the excavation of a portion of Phase I to allow construction of the initial refuse development. Controlled blasting may also be necessary to excavate some of the rock material. The excavated slopes will have an overall gradient of 2:1 or less with 15 to 20-foot wide benches located every 40 vertical feet. The upper slopes of excavations above the active cell will remain exposed until fill operations reach these areas and then the slopes will be lined.

The phased excavation of the GCLF will utilize two stockpile locations (see Figure 2) and/or unused areas within the footprint up to the proposed final grading contours. The stockpile areas will incorporate drainage and erosion control features to direct stormwater away from the active site.

C.2.9.1.3 INITIAL REFUSE PLACEMENT PROCEDURES

Special precautions will be taken during initial placement of refuse over the operations layer in newly completed liner areas. In these initial lifts, selected refuse will be screened visually to divert or remove bulky wastes, which could penetrate the 24 inches of protective soil and damage the liner system. These screening procedures will be implemented until one lift or a minimum of ten feet of refuse has been placed across newly lined areas.

C.2.9.1.4 REFUSE SLOPE STABILITY

An analysis of the slope stability of the landfill development is contained in Appendix C. Stability analyses of the planned final refuse fill configuration indicates that the static factor of safety decreases as the height of the refuse prism increases, but in all tested scenarios the calculated factor of safety exceeded 1.5. Since the static factor of safety increases as the length of the base of the refuse prism increases, landfilling in thin, full-length lifts across the entire base of the landfill will yield more stable conditions than landfilling in thick, short lifts. Therefore, the fill sequencing within Phases I, II, and III will be conducted in horizontal phases whereby refuse will be placed in relatively thin layers (e.g., 20 feet) across the entire landfill footprint from the bottom floor to the final elevations within a given phase.

Title 27, Section 21750 (f) (5) (B) states that the refuse prism must have a factor of safety of at least 1.5 under dynamic conditions, and that if this is not the case, a more rigorous analysis must be performed to estimate the magnitude of movement under seismic loading conditions. Since the results of pseudo-static (dynamic) analyses failed to yield a factor of safety greater than 1.5, displacement analyses were completed to evaluate the amount of displacement that could occur within the landfill and containment system under seismic loads associated with a M 7.1 earthquake (the design earthquake) on the nearby Elsinore fault. Dynamic stability analysis was performed for the MCE site acceleration of 0.40g using the methods of Bray and Rathje (1998). This method calculates the seismically induced permanent displacement for the fill slope due to the postulated MCE and is regarded to be more representative of actual conditions within a landfill than the TNMN computer software, which analyzes for a simple sliding block (Pyke, 1992). The procedure of Bray and Rathje (1998) involves estimating the maximum horizontal equivalent acceleration (MHEA) for the potential sliding wedge based on the slope geometry, material properties, and characteristics of the MCE. For the prescriptive standard design, the following parameters were used:

- Slope Height - 300 feet
- Average Shear Wave Velocity of Refuse Fill - 1,200 feet/second (Bray and Rathje, 1998)
- MCE Site Acceleration - 0.40g
- Mean Period of Shaking - 0.50 seconds (Bray and Rathje, 1998)
- Significant Duration of MCE - 16 seconds (Bray and Rathje, 1998)

Based on the analysis method of Bray and Rathje (1998), the displacements calculated to occur to the total refuse prism and liner is about 0.1 inches for the prescriptive configuration. This is within SWRCB policy maximum of 6 inches.

C.2.9.2 PHASE I

C.2.9.2.1 RATIONALE

The initial construction phase will include removal of the existing dairy buildings and residences on the site, removal of the manure to minimize or eliminate odors and/or potential impacts to water quality, the construction of the access road and bridge, improvements to SR76 at the access road, excavation of the river channel, the ancillary facilities, installation of the leachate and subdrain water storage tanks and the reverse osmosis system, excavation of the initial area of Phase I, and installation of the Phase I waste containment system within the excavated area (subdrain system, LCRS and composite liner), preparation of the Borrow/Stockpile Area A, clearance and grading of turnouts along the internal haul road between Borrow/Stockpile Area A and the landfill footprint, and installation of water quality monitoring wells. The initial construction period will be approximately nine to twelve months.

C.2.9.2.2 EXCAVATION

The initial development of the landfill will involve excavation of a portion of the Phase I area. It is anticipated that the initial excavation will be completed in an area of approximately 50 acres with approximately 34 acres lined to accommodate the first million tons of refuse received at the GCLF. The total Phase I excavation is approximately 3.7 mcy as shown on Figure 21B. Approximately 0.3 mcy of the 3.7 mcy will be required for the construction of the ancillary facilities area and SDG&E and to shape the canyon for receipt of the containment system. Excess soil and/or rock generated from the initial development will be processed and then stockpiled within the landfill footprint, in Borrow/Stockpile Area A, or exported off-site.

C.2.9.2.3 LINER SYSTEM DEVELOPMENT

Liner construction in the Phase I area will be completed in stages. As excavation and waste filling progresses in Phase I, the next stage of liner construction will commence. The liner system will be installed ahead of fill operations. In general, all subsequent phases will be similarly constructed in two-year stages in consideration of actual refuse inflow rates and associated capital expenditure.

The LCRS will be installed immediately upon completion of the liner and the main line will extend to a sump located at the northwest corner of the development area. The leachate will flow from the LCRS outfall to above-ground storage tanks designed to provide continued service in the event of system fluctuations.

C.2.9.2.4 WASTE FILL DEVELOPMENT

Upon completion of the first excavation in Phase I, the required base liner system will be constructed and fill operations will be initiated. Subsequent staged filling within Phase I will create a deck area at an approximate elevation of 600 feet amsl (Figure 21). Each stage will consist of a series of lifts. The lifts (typically 15 to 20 feet high) will be developed within the Phase I footprint while maintaining the minimum deck and side slope gradients. During the filling of Phase I, work will begin on the excavation of the next area or stage. Phase I will provide approximately 8.1 mcy of gross airspace and require approximately 1.6 mcy of soil for daily and intermediate cover. When completed, the north facing slope of Phase I will be at final grade. Landfill gas collection/recovery facilities will be installed at a pre-determined in-place refuse volume or as perimeter and surface monitoring dictates. At that time, extracted gases will be conveyed via header pipes to the flare station for destruction. These activities will be conducted and/or systems extended for all future phases of development.

C.2.9.2.5 DRAINAGE CONTROL DEVELOPMENT

Interim drainage control facilities will be constructed as required to control storm flows and prevent the inundation of the active face. Drainage control facilities will be placed along the interior benches above the lined slopes and direct flow into one of the perimeter channels and ultimately to the basins located at the north end the landfill. A desiltation basin and a portion of the perimeter storm drain channels will be constructed during the Phase I development. The surface water falling directly within the Phase I footprint will be directed, via grading and downdrains, to the buried perimeter drainage pipes. All drainage control facilities will be sized to carry the water from a 24-hour, 100-year storm event and a simultaneous rupture of the existing Pipeline Nos. 1 and 2 and the future Pipeline No. 6. Hydroseeding of final fill contours will be conducted to establish native vegetation. Once an area reaches 20 percent of pre-developed vegetative condition then storm water flows will be diverted to the perimeter channels. Section C.2.8.3.5 presents additional detail on stormwater management.

C.2.9.2.6 LANDFILL ACCESS ROAD/MAIN HAUL ROAD/BRIDGE

The GCLF project includes construction of an access road and bridge as well as widening of SR 76 near the access road entrance. The main access road from SR 76 will be a two or three lane paved road, approximately 32 to 36 feet wide. The road will extend through the abandoned Lucio dairy to the ancillary facilities area. The access road from SR 76 to the bridge will be wide and 910 linear feet with two 12-foot travel lanes and a four-foot shoulder on each side. The access road from the bridge into the ancillary facilities will be about 985 linear feet and will be 36 feet wide, with three lanes (two travel lanes and a center lane) with a four-foot shoulder on each side. The access road will be paved with asphalt curbs.

As the access road enters the ancillary facilities area, the access road will cross over the existing First San Diego Aqueduct. Two reinforced concrete slabs will be placed at grade, one centered over each pipeline. Each slab will be 26 feet wide and 64 feet in length placed on top of a layer of polystyrene. The three to four foot deep soldier beams at each end of the slab will absorb the weight of the vehicles crossing over the aqueduct.

A bridge, approximately 681 feet in length supported by five large diameter piers, which will form the base of the structure, will be constructed across the San Luis Rey River. The 35.5-foot wide bridge will have two travel lanes. For additional information regarding bridge design changes, refer to Section B.3.1.1 and Appendix B-2.

The main haul road leading from the entrance facilities to the active face will be routed to the northeastern corner of the Phase I cut slope. Upon completion of the Phase I fill, the haul road will curve sharply to the southwest and traverse from east to west at an approximate grade seven percent along the northern facing finished slope of Phase I (Figure 21). An interim bench splits off the haul road where it turns along the western edge of the fill area. The haul road will eventually terminate at the top of the Phase I fill. An interim bench will provide access to the Phase I temporary drainage basin and Phase II bottom area.

C.2.9.3 PHASE II

C.2.9.3.1 RATIONALE

Phase II development requires that an area be excavated and lined prior to the completion of refuse placement in the Phase I fill area.

C.2.9.3.2 EXCAVATION

Phase II will be excavated to a depth of approximately 525 feet amsl or 25 feet below ground level during filling of Phase I (Figure 22). Excess soil and/or rock generated will be utilized for Phase I daily cover, stockpiled, or exported off-site. The total Phase II excavation is approximately 3.7 mcy. Approximately, 0.76 mcy of the 3.7 mcy is required as fill material to shape the canyon for receipt of the containment system.

C.2.9.3.3 LINER SYSTEM DEVELOPMENT

As discussed earlier, liner placement will be implemented in stages throughout the development of Phase II to provide continuous refuse capacity and allow for the construction of the next stage. The LCRS will be installed over the liner along the bottom of this area and directly tie into the Phase I LCRS.

C.2.9.3.4 WASTE FILL DEVELOPMENT

Figure 23 shows the limits of the waste filling operation proposed for Phase II. Waste fill development will occur in stages within the entire Phase II footprint, in a fashion similar to that used in Phase I. Upon completion of landfilling in the final stage of Phase I, landfill operations will move to the first stage of Phase II. When completed, Phase II will extend the fill up-canyon and the top deck of the refuse fill will reach elevations of 675 feet amsl. The Phase II gross fill capacity is approximately 6.3 mcy.

C.2.9.3.5 DRAINAGE CONTROL DEVELOPMENT

Drainage control facilities will be constructed as required to control storm flows at all times. Most drainage from the Phase II deck area will be diverted into the west and east buried drain pipes by proper grading of a deck ridgeline. The PSD will be constructed up-canyon to upper limits of the cut to divert stormwater run-on from the surrounding undisturbed areas. Once an area reaches 20 percent of pre-developed vegetative condition then storm water flows will be diverted to the perimeter channels.

C.2.9.3.6 LANDFILL INTERNAL ACCESS ROADS

The access road from Phase I will curve sharply to the southwest to provide access to the top deck area of Phase II.

C.2.9.4 PHASE III AND IV

C.2.9.4.1 RATIONALE

Phases III and IV are the final excavation and refuse fill development phases for the GCLF. Phase III and IV excavations and liner construction are necessary to accommodate final refuse fill placement and must be completed prior to completion of the Phase II fill area.

C.2.9.4.2 EXCAVATION

Once the Phase II excavation is complete two small final phases of excavation (Phases III and IV) are proposed prior to and in conjunction with Phase III fill operations. Phase III excavation is the final area in the uppermost (southern) limits of the canyon and involves excavation of approximately 489,000 cubic yards of soil and rock (Figure 24). Phase IV includes a small area along the west side of the refuse footprint (about half way up the canyon) and will involve approximately 23,000 cubic yards of excavation (Figure 25). Approximately, 111,000 cy of the Phase III/IV excavation will be required to shape the canyon for receipt of the containment system.

C.2.9.4.3 LINER SYSTEM DEVELOPMENT

Liner system development in the Phase III and IV areas will include only slope liner construction and will complete the overall liner system for GCLF. As part of the Phase III and IV liner system construction, the LCRS mainline and LCRS risers will be extended up the slope to daylight.

C.2.9.4.4 WASTE FILL DEVELOPMENT

Phase III fill operations will complete the landfill to the final grading configuration, shown on Figure 26. The final deck will reach elevations of approximately 1,100 feet amsl and Phase III will provide approximately 43.1 mcy of gross airspace. Several fill stages will be employed within the Phase III footprint and incremental closure of the landfill may be implemented as disposal continues at higher elevations.

C.2.9.4.5 DRAINAGE CONTROL DEVELOPMENT

The final drainage system configuration will be completed as part of the Phase III fill and final cover construction. All surface water facilities will be constructed to handle a 24-hour, 100-year storm event. Drainage from the deck area will be directed by deck berms into downdrains and eventually into the buried drain pipes along the perimeter of the site. The PSD will be constructed up-canyon to upper limits of the cut to divert stormwater run-on from the surrounding undisturbed areas. Once an area reaches 20 percent of pre-developed vegetative condition then storm water flows will be diverted to the perimeter channels. The final configuration of the drainage control system is shown on Figure 17.

C.2.9.4.6 LANDFILL INTERNAL ACCESS ROADS

The main haul road will extend from Phase II and traverse from east to west along the northern facing finished slope of Phase III (see Figure 26). The haul road will curve sharply back from west to east and traverse the eastern facing finished slopes before reaching the top deck. The haul road alignment is designed to provide access and facilitate drainage for the final landfill configuration.

SECTION C.3

DESIGN CALCULATIONS

C.3 DESIGN CALCULATIONS

C.3.1 SITE CAPACITY

The GCLF design plans presented in Section C.2 reflect a net airspace of approximately 57.5 mcy. Information used to determine the site's overall capacity is discussed in Section B.1.6.

C.3.2 SOIL AVAILABILITY

Based on the geophysical study of potential borrow areas, soil materials for daily and intermediate cover of active waste disposal operations will be obtained from three on-site sources: the landfill footprint itself, and two borrow areas - Borrow/Stockpile Area A will be located west of the landfill footprint (adjacent to the western boundary) and Borrow/Stockpile Area B will be located immediately southwest and adjacent to the landfill footprint. The landfill development will include the excavation of topsoils, alluvium/colluvium or weathered bedrock from within the footprint of the landfill. Excavated colluvium and weathered bedrock material will be stockpiled for use during the operation and closure of the landfill. Unweathered rock materials will also need to be excavated from within the footprint, but these materials would need to be crushed and processed before they could be used in cover applications. A comparison of needed and available resources suggests a deficit of soil materials. This potential deficit will be offset by on-site processing of rock material by mechanical means or weathering of material. In addition, geosynthetic fabric ADC will be used during refuse operations. For additional information on material availability, refer to Section C.2.2.3.

C.3.3 SETTLEMENT ANALYSIS

Permanent survey monuments will be installed in accordance with 27 CCR, Section 20950(d) to provide both horizontal and vertical control points by which to monitor settlement of the final site face during the post-closure period. In addition, an aerial photographic survey will be performed and provided to the RWQCB, LEA, and CIWMB upon completion of all closure activities in accordance with 27 CCR, Section 21090(e)(1). In accordance with 27 CCR, Section 21090(e)(2) requirements, the operator will prepare an iso-settlement map of the entire permitted site every five years throughout the post-closure maintenance period.

Settlement analyses have also been performed for the GCLF as part of the closure requirements in 27 CCR, Section 21142. Results of these analyses are discussed in Section E.1.4 and included in Appendix C.

C.3.4 LEACHATE GENERATION

Leachate is formed when surface water infiltrates or any free liquids inherent to waste migrate through the refuse prism. The GCLF will be operated to inhibit leachate formation by minimizing surface water infiltration. In addition, the containment system design for the landfill area includes a LCRS above the composite liner to collect and remove leachate that may be generated.

In order to size and locate the LCRS components, modeling of potential leachate generation at GCLF was completed using the HELP3 computer program. HELP3 uses site-specific or default rainfall and evapotranspiration data to estimate leachate quantities, which might be generated at the landfill. Based on the results of the HELP3 model, it is anticipated that generally small volumes of leachate will be generated in the landfill during active operations and after closure. The results of the modeling are discussed in Sections B.5.1.1 and C.2.5 and the complete leachate generation analysis is included in Appendix C.

C.3.5 DRAINAGE SYSTEM CAPACITY REQUIREMENTS

The location of the GCLF precludes inundation of the landfill by a 100-year flood. In addition, the various drainage control features have been designed to control surface water run-off from a 24-hour, 100-year rainstorm event. Supporting calculations for the GCLF's drainage control system design configuration are contained in Appendix J.

C.3.6 GAS GENERATION AND AIR EMISSIONS CALCULATIONS

In accordance with the San Diego APCD regulations, a landfill gas control/recovery system will be installed at the GCLF. Information regarding estimated gas generation and air emissions was considered in the design of the gas control/recovery system. The landfill gas generation information utilized in the EIR is presented in Appendix K.

C.3.7 SOIL EROSION ANALYSIS

A soil erosion analysis was performed for the GCLF. The soil loss analysis map is shown in Figure 27 and additional information regarding the soil loss analysis results is included in Section E.1.7.2 and Appendix L.

C.3.8 SEISMICITY

The seismicity of the GCLF, including the location of the site with respect to active and potentially active faults and their potential impacts to the waste containment units from seismic events, is discussed in Sections D.4.4 and D.4.5. Analyses of refuse and excavation slope stabilities under earthquake loads at the GCLF are presented in Appendix C.

SECTION C.4

CONSTRUCTION QUALITY ASSURANCE

C.4 CONSTRUCTION QUALITY ASSURANCE

C.4.1 INTRODUCTION AND PURPOSE

The construction quality assurance (CQA) program includes all relevant aspects of construction quality control (CQC). It provides a description of the materials and procedures to be used for construction of the composite liner and final cover systems and provides CQA monitoring and testing protocols and frequencies to be performed during construction to assure the regulatory agencies that the construction materials will be tested, installed, and monitored as specified in the design plans and specifications, and that accepted civil engineering practices will be used.

The CQA Plan will be prepared by a registered civil engineer or a certified engineering geologist and will present the requirements and procedures to be implemented during construction in accordance with 27 CCR, Sections 20323 and 20324. Included in the CQA Plan is a discussion of the professional qualifications of personnel who prepare and oversee the CQA program, the reports addressing construction requirements set forth in the design plans, documentation to be completed as part of the CQA program, and appropriate laboratory and field testing procedures and requirements for materials used in constructing the containment systems. The final construction documents will include detailed plans and specifications for all major contract elements as specified in 27 CCR, Section 20324(d)(1)(C). As required in 27 CCR, Section 20324 (c) (1)(B), the CQA Plan (or Report) will also specify the minimum training and experience requirements for contractors, work crews, and inspectors. In accordance with the requirements of 27 CCR, Section 21790, a CQA Plan for the final cover system was prepared and is included as Appendix M. A CQA Plan for the liner is included as Appendix N. The following discussion presents general CQA procedures.

C.4.2 RESPONSIBILITY AND AUTHORITY

In accordance with 27 CCR, Section 20324(b)(2), a registered civil engineer or certified engineering geologist will be designated as the CQA Officer and will be responsible for overseeing the CQA program, including observing the installation of the composite liner and final cover system components and evaluating the materials for conformance with the plans and specifications, and all testing completed for the project during and after construction. The responsibilities of the CQA Officer will include:

- Review design plans and specifications for accuracy and completeness.
- Prepare a schedule of CQA inspections and coordinate necessary CQA personnel to conduct inspections.
- Review and interpret data and reports prepared by CQA inspection personnel.

The CQA inspection personnel will perform various tests and observations during construction activities as required by 27 CCR, Section 20324(d) through (i), such as:

- Verify that testing equipment is properly calibrated on a regular basis and document the calibration.
- Accurately record test data and organize it in a manner that allows easy reference.
- Evaluate the contractor's construction quality control plans to ensure that they meet or exceed the facility CQA Plan requirements.
- Report observations and test results as the work progresses.

The CQA inspection personnel will work under the supervision and guidance of the CQA Officer who will be responsible for verifying that all tests are conducted in accordance with the appropriate American Society for Testing and Materials (ASTM) standards or other specified test methods, and that the proper test equipment is used as specified in 27 CCR, Section 20324(e) and (f). The results of all inspections, including work that is unacceptable, will be reported to the CQA Officer.

C.4.3 PERSONNEL PROFESSIONAL QUALIFICATIONS

Under 27 CCR, Section 20324(b)(1) and (2) and as stated above, the design professional that prepares the CQA Plan will be a registered civil engineer or certified engineering geologist, and the CQA program will be overseen by a similarly registered/certified professional. The CQA plans for the final cover and liner containment systems, included as Appendices M and N, respectively, include a delineation of the CQA management organization, as required under 27 CCR, Section 20342(c)(1)(A).

In accordance with 27 CCR, Section 20324(c)(1)(B), the project CQA Report must include a detailed description of the level of experience and training for the contractor, work crew and CQA inspectors for every major phase of construction in order to ensure that the installation methods and procedures required in the containment system design will be properly implemented. This information will also be included in the construction contract documents and is summarized in this section. The CQA team will consist of a CQA Officer and inspectors overseeing the project contractor and work crews and whose qualifications will be as follows:

C.4.3.1 CQA OFFICER

The CQA Officer will have formal academic training in engineering or geology and will be registered as a professional engineer or certified engineering geologist in the State of California. This person should have practical, technical, and managerial experience that will allow the CQA Plan to be properly implemented. The CQA Officer must be able to communicate effectively with the landfill personnel, design engineers, and contractors to facilitate a clear understanding of construction activities and the CQA Plan.

C.4.3.2 CQA INSPECTION PERSONNEL

CQA inspection personnel must have formal training and practical experience in inspecting and testing construction work relative to solid waste disposal sites, including conducting and recording inspection activities, preparing daily reports, and performing field testing.

C.4.3.3 GEOSYNTHETIC INSTALLATION CONTRACTOR AND WORK CREW

The Geosynthetic Installation Contractor shall have successfully installed a minimum of 10 million square feet of similar geosynthetic material in solid waste containment structures. The geosynthetic placement superintendent shall have successfully installed a minimum of 5 million square feet of geosynthetic material in solid waste containment structures. The seaming personnel shall have prior experience in the installation of a minimum of 1 million square feet of similar geosynthetic materials. The Contractor shall submit project names, sizes, and references with current telephone numbers. Resumes shall be submitted for the superintendent and seaming personnel.

Prior to installation of the geomembrane, the Geosynthetic Installation Contractor shall instruct workers on safety procedures pursuant to local, State and Federal regulations. The Contractor shall instruct the workers relative to the difficulties and potential hazards involved in handling the geomembrane. In addition, the Contractor shall ensure that workers have and use safety gear and equipment required by regulation. On-site technical supervision and assistance shall be provided at all times during installation of the geosynthetics.

C.4.4 INSPECTION ACTIVITIES AND REPORTING

Throughout the construction of the composite liner and final cover systems, the CQA team will perform inspection, observation and testing, which will be thoroughly documented, as detailed in the approved CQA Plan. The inspection, testing, and reporting elements of the CQA Plan identified in 27 CCR, Section 20324(c) are included in more detail within the final cover and liner CQA plans included as Appendices M and N in this JTD. These activities, which are summarized below, are divided into pre-construction, construction, and post-construction activities.

C.4.4.1 PRE-CONSTRUCTION

Pre-construction inspection activities of the CQA team will generally include:

- Review of design criteria, drawings, and specifications associated with construction of the landfill.

- Inspection of materials proposed for construction (e.g., material properties data sheets for geosynthetic membrane and geosynthetic clay),
- Review of manufacturing operations and finished product specifications and quality control certificates,
- An inspection of the manufacturing process and quality control procedures employed in the manufacturing of the geosynthetic materials.
- Review of fabrication operations (e.g., factory seaming),
- Review of Contractor submittals including shop drawings, material certifications, and conformance data,
- Observations related to the transportation, handling, and storage of the geosynthetic membrane and geosynthetic clay,
- Inspection of the foundation conditions.

Additional detailed descriptions of the pre-construction activities are provided in the CQA plans in Appendices M and N of the JTD. The liner CQA Plan (included as Appendix N in the JTD) describes the geosynthetic pre-installation meeting (Section 4.4) and a plant visit to observe liner material manufacturing (Section 4.6). A discussion of the handling and storage of the geomembrane (HDPE), geosynthetic clay liner, geotextiles, and geocomposite materials are provided under the specific materials section of the CQA Plan.

C.4.4.2 CONSTRUCTION

The construction inspection activities of the CQA team will generally include:

- Review of contractor's submittals, samples, and supporting test reports.
- Review of the contractor's work schedules.
- Verification that materials are as specified in the plans and specifications or as approved by the engineer.
- Observation of all phases of the construction and documentation of the contractor's compliance or noncompliance with the approved plans and specifications, and/or the direction of the engineer. Field tests and visual observations will be used to evaluate construction practices.
- Accommodate seasonal conditions, if warranted.

Testing Program

In accordance with 27 CCR, Sections 20324(e) and (f), laboratory and field testing programs will be implemented prior to incorporation of the material into the containment system and once approved, during construction to evaluate whether all components are constructed according to the design specifications. All field tests will be conducted by CQA personnel or qualified laboratories under the supervision of the CQA personnel.

Test Fill Pad. In accordance with 27 CCR, Section 20324 (g), prior to actual liner construction, a test fill pad (demonstration fill) will be constructed to evaluate both the low-permeability soil proposed for liner construction and the Contractor's equipment and methods for constructing and maintaining the integrity of the low-permeability liner soils. The test fill pad foundation will be constructed by the Contractor selected to complete liner construction with the designated equipment to determine if the specified density/moisture content/hydraulic conductivity relationships determined in the laboratory can be achieved in the field with the compaction equipment to be used and at the specified lift thickness and to establish the correlation between the design hydraulic conductivity and density at which that conductivity is achieved.

The test fill pad testing will be completed a minimum of two weeks prior to the actual low-permeability liner construction. Soil sampling will be performed by the Geotechnical CQA Monitor(s) during and after construction of the demonstration test fill pad to provide data regarding soil properties obtainable using the proposed design and construction methods. If necessary, the results from the test fill construction and testing program will be used to modify the Project Specifications for low-permeability liner construction. Additional discussion of the test fill pad (Demonstration Fill) and testing program is provided in the CQA Plan for liner construction in Appendix N.

Earthen Fill Materials. At a minimum, in accordance with 27 CCR, Section 20324(h), for compacted earthen fill materials, maximum density/optimum moisture content testing (by ASTM D1557) will be performed at a frequency of one test for every 5000 cubic yards of material placed, or per change in material type. Field compaction testing will be conducted by nuclear gauge at a minimum frequency of four tests per 1000 cubic yards and evaluated by sand cone methods at a minimum frequency of one test per 1000 cubic yards placed. The low permeability layer of the composite liner system will be constructed with import soils derived from a source approved by the Geotechnical Consultant. Import materials to be used in the low-permeability layer will be evaluated by the Geotechnical Consultant according to the following minimum testing schedule in order to characterize material properties:

Low-Permeability Import Material Testing Type and Frequency

Test Description	Test Designation	Minimum Test Frequency
Particle Size Analysis	ASTM D422	One per 2000 yds^3 stockpiled or one per production day (minimum)
Atterberg Limits	ASTM D4318	One per 2000 yds^3 stockpiled or one per production day (minimum)
Classification of Soils for Engineering Purposes	ASTM D2487	One per 2000 yds^3 stockpiled or one per production day (minimum)
Processed Moisture Content (following moisture conditioning)	ASTM D4643 (microwave) or ASTM D2216 (oven)	Two per construction day
Laboratory Permeability	ASTM D5084/EPA 9100 or USBR Modified E-13	One per 10,000 c.y
Moisture/Density Relationship	ASTM D1557	One per 10,000 c.y.
Visual Inspection	ASTM D2488	Daily while stockpiling

No soils other than those obtained from the approved borrow source and/or approved by the Geotechnical Consultant will be used in liner construction.

Select import soils will be screened (if necessary), dried, and/or moisture conditioned until uniformly blended material characteristics and moisture condition are attained. Field and laboratory testing for moisture content, in-place dry density, and engineering and permeability properties during construction of the low-permeability layer of the liner system will be completed according to the following minimum schedule:

Low-Permeability Fill Testing Type and Frequency

Test Description	Test Designation	Minimum Test Frequency
Processed Moisture Content (following moisture conditioning)	ASTM D4643 (microwave) or ASTM D2216 (oven)	Two per construction day
Moisture-Density Relationship	ASTM D1557	One per 5,000 cubic yards or per change in material type

In-Place Moisture-Density (Nuclear and/or Drive Ring)	ASTM D2922 ASTM D3017 ASTM D2937	One per 250 cubic yards placed
In-Place Density and Moisture Content (Sand-Cone)	ASTM D1556	One per 1,000 cubic yards placed or 20 percent of total In-Place tests (whichever is greater)
Particle Size Analysis	ASTM D422	One per 5,000 yd^3 (conducted on samples retrieved for laboratory permeability testing)
Atterberg Limits	ASTM D4318	One per 5,000 yd^3 (conducted on samples retrieved for laboratory permeability testing)
Laboratory Permeability	ASTM D5084/EPA 9100 or USBR Modified E-13	One per 5,000 cubic yards placed
Field BAT Permeability		One per 2,500 cubic yards placed
Visual Inspection	ASTM D2488	Daily

Geosynthetic Materials. The project CQA plans (Appendix M and N, Section 6.0) include detailed descriptions of performance requirements and minimum criteria for the geosynthetic materials. The following sections summarize this portion of the CQA plans to be implemented for geosynthetic materials construction.

During delivery of geosynthetic materials, the Contractor or Liner Subcontractor shall ensure that conformance samples are obtained in the presence of the Geotechnical CQA Monitor or his/her designated representative and forwarded to the Independent Testing Laboratory. Unless otherwise specified, conformance samples shall be taken and tested at a rate of one per lot or one per 100,000 square feet, whichever results in the greater number of tests. Testing for interface shear will be conducted at a rate of one per 200,000 square feet. At a minimum, conformance tests will include determination of the following characteristics for the HDPE (composite liner system):

- Density (ASTM D1505A).
- Environmental Stress Crack (ASTM D5397).
- Tear Resistance (ASTM D1004 Die C).
- Carbon black content (ASTM D1603).
- Thickness (ASTM D5199).
- Tensile characteristics (yield strength, elongation at yield, break strength, elongation at break) (ASTM D638).
- Interface shear strength testing as described in the Project Specifications. Direct shear testing for interface strength shall be carried out in accordance with ASTM D-5321 "Standard Test Method for Determining the Coefficient

of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method." Issues and procedures related to soil preparation shall be governed by ASTM D3080.

- Puncture resistance (ASTM D4833).

Where optional procedures are noted in the test method, the requirements of the Project Specifications shall prevail.

The CQA Plan for the final cover system including testing requirements and frequencies for earthen materials and the geosynthetic materials (LLDPE) is included as Appendix M.

Liner System Electrical Leak Location Survey. To aid in CQA monitoring of the as-built liner system, an independent contractor will conduct an electrical leak location survey as part of the final quality control for the geomembrane installation. The method is designed to identify holes in the geomembrane liner after the LCRS gravel, or LCRS gravel and operations layer soil, has been placed. As such, the survey will be performed after the geomembrane has been subjected to construction activities. One last survey will be conducted once the first refuse lift (a minimum of 10 feet) is placed.

The survey involves making point-by-point electrical measurements on the soil above and below the liner and because the geomembrane liner is an electrical insulator, current will flow only through leaks in the liner, producing localized anomalous areas of high current density near the leaks. With the proper implementation of equipment and survey procedures by our survey contractor, the electrical leak location method can detect and locate 0.01 square inch leaks in liners covered with 2 feet of soil (LLSI, 2003; www.leaklocationservices.com).

Documentation. *Daily Summary Reports* - In accordance with 27 CCR, Section 20324(d)(1)(A), a summary report will be prepared daily by each technician with supporting inspection data sheets and records of any problems that occur or corrective measures that are implemented throughout the construction period. The daily summary reports will provide a chronological framework for identifying and recording all other reports. Inspection data sheets will contain all observations, and a record of field and/or laboratory tests. At a minimum, daily reports will include the following:

- Date, name of project, and location.
- Weather and site conditions.
- Summary of any meetings conducted and the results of the meetings other than formal periodic meetings.
- Location of daily construction activities and progress.
- Record of equipment and personnel working areas.
- A record of field and/or laboratory tests including the location of work being tested and areas passing final inspection.
- Description and condition of any materials received at the site.
- Record of equipment calibrations or recalibrations and any actions taken as a result of recalibration.
- Site visits by others.
- Identification of construction problems and their solution or disposition summarized into a corrective measures report.

The corrective measures report will include detailed descriptions of materials and/or workmanship that do not meet a specified design and will be cross referenced to the specific inspection data sheets where the problem was identified and corrected.

Monthly Construction Summaries. Monthly construction summaries will be prepared by the CQA Officer and include the following items:

- Inspection dates.
- Time spent on the site.
- Activities performed.
- Tests performed.
- Specific locations inspected.
- Methods used in analyzing sample results for the purpose of construction quality assurance.
- Summary of the completed daily inspection forms.

Acceptance of Completed Components (Acceptance Reports). The CQA Officer will review daily inspection reports, inspection data sheets, and inspection photographs. All inspection reports will be evaluated for internal consistency, accuracy, and completeness.

The above daily reports and problem identification and corrective measures reports will be summarized into periodic acceptance reports, which will indicate that the materials and construction processes have been completed according to the specified design. The acceptance reports will, at a minimum, include inspection summary reports, inspection data sheets, and problem identification and corrective measures reports. These reports will be included in the project files and will be available to regulatory agencies upon request.

Document Control and Storage. During construction, the CQA Officer will be responsible for all CQA documents and on-site organization of the documents for easy access. The CQA Officer will also be responsible for keeping duplicate records of all documentation at another location.

The CQA Officer will be responsible for incorporating any revisions to the CQA Plan and distributing revised copies to the construction contractors and all other relevant parties.

Upon completion of construction, the facility will store all original documents so that they are protected from damage throughout the post-closure maintenance period, yet can be readily accessed.

C.4.4.3 POST-CONSTRUCTION FINAL DOCUMENTATION

At the completion of each phase of liner construction and following final cover construction, a final report will be prepared by the CQA Officer to provide evidence that the CQA Plan was implemented as proposed and that construction proceeded in accordance with design criteria, plans and specifications. The final report will include:

- Daily inspection summary reports.
- Inspection data sheets.
- Photographic reporting data sheets.

- As-built reports.
- Deviations from design and material specifications (with justifying documentation).

A statement that the liner has been built in general conformance with the design specifications, the approved plans, and the approved modifications of the plans and specifications will be provided and included in the final documentation sent to the appropriate regulatory agencies. The report will be signed by the CQA Officer, who is a registered civil engineer or certified engineering geologist.